SECOND REPORT

OF THE

MUNICIPAL COMMISSIONERS

OF

CALCUTTA,

ON THE

PROGRESS OF THE WORKS CONNECTED

WITH THE

DRAINAGE AND SEWERAGE OF THE TOWN.

CALCUTTA:

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1861.

REPORT.

FROM

THE MUNICIPAL COMMISSIONERS
FOR THE TOWN OF CALCUTTA,

To

THE HONORABLE J. P. GRANT,
Lieutenant-Governor of Bengal,
FORT WILLIAM.

Dated the 1st June 1861.

HONORABLE SIR,

WE have now the honor to submit our Report on the progress of the Experimental Works in connection with the new system of Drainage and Sewerage of this Town, as authorized by the orders of Government, conveyed in Mr. Secretary A. R. Young's letter No. 2498, dated the 16th April 1859.

2. From the details furnished by our Engineer, Mr. Clark, herewith annexed, marked Appendix A, it will be perceived that the Experimental Works are rapidly advancing towards completion, and that, moreover, provision has been made for not only bringing them into practical use with as little delay as possible, but also for extending the system at once to the remaining thoroughfares of the Southern Division of the Town, should the result of the

experiment prove as satisfactory as we have every reason to anticipate.

3. On the very serious difficulties encountered in the practical execution of the works, we need not here dwell, as they are so well described by our Engineer, to whose Report we commend attention, and it is particularly gratifying to have it in our power to state that, notwithstanding the various serious drawbacks and impediments to which our Engineer has been subjected, the mainworks themselves have steadily progressed under every disadvantage, though little more than two years have elapsed since the orders of Government for a commencement were received. The Experimental Works have now so far advanced towards completion, that there is every probability of their being, by the end of the current year, put into such a state as to admit of their practical use being tested.

4. The experimental works comprise the following Mains or Sewers, &c. :—

	Length.
Dhurrumtollah, 1st Class Main Sewer, from Circular Road to Chandpaul Ghaut	8,900
Old Court House Street, 2nd Class Sewer, from Esplanade Road to Scotch Kirk ...	2,400
Chowringhee Road, 2nd Class Sewer, from Dhurrumtollah	4,742
Great Receiving Sewer at Entally ...	600
	16,642

and the works for the temporary Pumping Station at the head of the old Cess-pool, Balliaghatta.

Of these, on the 1st of May, 15,060 feet of arched masonry were completed, as follows:—

	Feet.
Dhurrumtollah Main Sewer ...	8,110
Old Court House Street (completed) ...	2,400
Chowringhee Road	4,250
Main Receiver at Pumping Station ...	300

whilst the brick-work connected with the Pumping Station has been brought up to the level of the adjacent ground. There is, therefore, every reason to expect that the remaining portion will be completed by the end of this year.

5. In addition to the above, the following junctions, man-holes, and surface drainage junctions, comprising heavy masonry work of importance, have been effected, for the purpose of saving the Mains from being again broken into, when the arterial drainage is to be carried out:—

At Premises No. 72 ...	Junctions.	Along the Dhurrumtollah Main Sewer.
„ Dinga Banga Lane ...		
„ East side of Union Chapel ...		
„ St. James' Lane ...		
„ Mott's Lane ...		
„ Gungaram Paulit's Lane ...		
„ East side of Wellington Square ...		
„ Wellesley Street ...		
„ Wellington Street ...		
„ Jaun Bazar 4th Lane ...		

At Hospital Lane ...
„ Nilmony Holdar's Lane ...
„ Chandney Choke Street ...
„ Cossitollah ...
„ Chowringhee Road ...
„ Dacre's Lane ...
„ Government Place, East ...
„ Government House Compound ...
„ Government Place, West ...

} Junctions.

} Along the Dhurrumtollah Main Sewer.

At East gate of Union Chapel Compound ... ...
„ East corner of Wellesley Street ...
„ Ditto Jaun Bazar 4th Lane ...
„ Ditto Old Court House Street ...
„ West corner of Government Place, West ...

} Side Entrances.

37 Man-holes.
150 Junctions for surface drains.

} Along the Dhurrumtollah Main Sewer.

At Banstollah Gully ...
„ Waterloo Street ...
„ Government Place, North ...
„ Raneemoody Gully ...
„ Larkin's Lane ...
„ Tank Square, South ...

} Junctions.

„ North-East corner of Government House Compound ...
„ South-East corner of Tank Square Compound ...

} Side Entrances.

12 Man-holes.
60 Junctions for surface drains.

} In Old Court House Street.

At Jaun Bazar Street	...	Junctions.	In Chowringhee Road.
„ Maxton's Lane	...		
„ Hoomayoon Place	...		
„ Lindsay Street	...		
„ Sudder Street	...		
„ Kyd Street	...		
„ Park Street	...		
„ North corner of Lindsay Street	...	Side Entrances.	
„ Ditto Kyd Street	...		
24 Man-holes.			
70 Junctions for surface drains.			

6. From the foregoing will be perceived that due arrangements have been made for completing all side drains from gullies and surface drains, as well as the connection of all house drains with the Main Sewer, and its collateral branches, whenever it may become desirable.

7. Before adverting to other details, we beg to refer to Appendices B, C, and D, containing the audited statements of the expenditure incurred since the beginning of 1858, but in order to exhibit the total outlay in connection with the Drainage Works since the very commencement, as well as the value of stock and plant and of material in hand, it is necessary to show the sums expended in the aggregate during that period under their respective heads. They are as follows :—

Purchase of Land at Kootrung for Brick Field, and at Balliaghatta for Work-shops	Rs.	80,419	0 2
Carried over ...	Rs.	80,419	0 2

Brought forward ... Rs.	80,419	0	2
Workmen's Wages for erection of Buildings ... ... „	34,367	13	0
Machinery ... ... „	74,613	9	7
Rails for Tramways, &c. ... ... „	5,135	4	9
Implements ... ... „	54,376	[illegible]	10
Water carriage for Materials and Machinery ... ... „	36,316	11	0
Coal ... ... „	49,512	11	11
Lime ... ... „	28,578	5	2
Soorkey ... ... „	6,655	0	9
Timber ... ... „	56,625	14	11
Iron ... ... „	843	9	3
Bricks (Workmen and Contractors) ... „	1,25,663	8	7
Establishments and Superintendence ... „	1,15,533	15	7
Cattle and Carts ... ... „	3,691	6	9
Boats ... ... „	2,556	0	0
Furniture ... ... „	528	4	2
Medical Attendance and Medicines ... „	550	0	0
Wages to Bricklayers, Coolies, Classies, and Workmen, for excavating and constructing Sewers, ... „	1,75,153	0	3
Stone-ware Pipes for minor Drains (Stock) ... ... „	53,517	2	4
Removal of surplus Soil ... ... „	12,991	0	0
Surface Channels and Channel Stone ... „	9,034	13	1
Iron Gratings ... ... „	2,144	6	8
Cost of reference to Messrs. Rendell, C. E. ... ... „	1,963	10	3
Law Charges ... ... „	1,327	10	3
Levelling and Tidal Observations ... „	1,682	12	0
Carried over ... Rs.	9,33,782	9	3

Brought forward ...	Rs.	9,33,782	9	3
Lighting and Fencing. Excavations ...	„	3,939	11	7
Contingencies (Printing, Stationery, &c.)	„	2,441	1	7
Total, Rupees ...		9,40,163	6	5

8. Against this sum of Rupees 9,40,163-6-5, we have to set off the value of stock and plant, as well as of the materials on hand. They are as follows :—

Value of our Steam Works at Kootrung, including cost of Land, Buildings, Machinery, Tramways, and Trucks	Rs.	2,26,120	11	8
Value of the Balliaghatta Depôt, including cost of Land, Buildings, and Machinery	„	33,340	14	8
Value of *Paulit's* Land at Entally ...	„	9,286	0	0
Total, Stock and Plant,	Rs.	2,68,747	10	4

Materials.

Stone Pipes	Rs.	53,517	2	4	
Implements and Machinery	„	41,625	10	7	
Bricks ready burned ...	„	68,000	0	0	
Timber and Sundry Material	„	10,000	0	0	
					1,73,142 12 11
Total, Stock and Plant and Material,	Rs.				4,41,890 7 3

So that the actual outlay in connection with the Drainage Works themselves, as constructed up to date, is Rupees 4,98,272-15-2, as marginally noted.

Total outlay	Rs.	9,40,163	6	5
Plant and Stock..	„	4,41,890	7	3
Balance, Rs. ...		4,98,272	15	2

9. But even this sum is susceptible of further analyzation. It is obvious that among the items enumerated in para. 7, there are several which cannot fairly be charged entirely to the cost of the Sewers already constructed, but form a contingency of the expense which the total works will involve. These items are the taking of the levels of the whole Town, and of tidal observations; the reference to Messrs. Rendell; law charges in effecting the purchases of land, and contingencies, amounting to Rupees 11,354-13-8. It must also be borne in mind, that during the first two years, before any excavated works could actually be commenced, the Engineer's and his establishment's time was devoted to the preparation of numberless drawings, superintendence of the steam works at Kootrung and of the Balliaghatta Depôt in the course of erection, as well as to the construction of various implements, and, above all, the manufacture of bricks of the finest quality, all absolutely necessary, when the Drainage Works themselves were to be commenced upon. This involved an expense of Rupees 35,435-7-10, and must likewise be proportioned over the whole of the Drainage Works. More-

over, a sum of about Rupees 18,000 is due to the Drainage Department from the General Conservancy Funds for road metal supplied from the steam works at Kootrung. These various items aggregate Rupees 64,790-5-6, reducing the actual outlay in the construction of the Drainage Works to Rupees 4,33,482-9-8.

10. Of the expenditure of this latter sum the following specifications may be noted:—

Cost of 8,770 feet of Surface Channels, constructed of solid stone	Rs.	11,179	3	9
Ditto of removing surplus Soil ...	„	12,991	0	0
Ditto of constructing 15,060 of running feet of Main and Collateral Sewers, comprising 32 junctions, 9 side entrances, 73 man-holes, and 280 junctions for surface drains	„	4,09,312	5	11

And of the latter sum the items are as follows:—

Rs.	2,78,407	14	10	for the construction of the Dhurrumtollah Main Sewer.
„	22,573	4	0	for the construction of the Old Court House Street branch.
„	42,820	15	8	for the construction of the Chowringhee Road ditto.
„	65,510	3	5	for the junctions, side entrances, and junctions for surface drains, and a portion of the Main Receiver at Entally.

The above includes every expense connected with the undertaking, such as excavations, shoring, brick-

works, cartage, filling in excavations, labor and superintendence.

11. It will thus be observed that the construction of the Dhurrumtollah deep Main Sewer of the first-class costs, at an average, Rupees 34-5-3 for every *lineal* foot; of the second class, a smaller Sewer in Old Court House Street, Rupees 9-6-6, and of that in Chowringhee Road, Rupees 10-1-2. These rates certainly are above the original estimate submitted in 1856, by the Engineer and others; but, considering the great rise in the price of labor and materials, owing to various conflicting causes well understood by the Government, it is less than it could have been the case, if we had not made such timely and effective arrangements for manufacturing our own bricks at Kootrung, which, whilst they are unmatched in quality, stand in at a considerably less price than at what they could be procured in the market.

12. The construction of the above Main Sewer, with its branches, has necessitated the excavation of 26,05,828 feet of earth; the masonry work consists of 5,39,264 cubic feet, and contains 80,14,209 bricks, and after filling in the excavations, 10,36,600 cubic feet of surplus soil remained to be removed. The above is exclusive of junctions, side entrances, manholes, and junctions for surface drains.

13. With regard to the value of stock and plant, as well as the materials on hand, we have to observe

that the same has been calculated at actual cost, but we have not the least doubt, that, if at present disposed of, the same would realise considerably more, as the price of land, labor and material has since risen fully 50 per cent. The land at Balliaghatta, for which we paid Rupees 4,551, is at the present rate *paid* for ground near that locality worth Rupees 12,000, whilst that at Kootrung, which, in the aggregate, stands in at a cost of Rupees 66,582-0-2, would now find ready purchasers at a lakh of Rupees. The whole of the buildings moreover have been erected by the people on the establishment, and after debiting every possible item of superintendence and contingencies which their erection involved, the aggregate cost is considerably under the estimates at which they could have been built by contract, whilst the material used in their construction is of the very best description.

14. Among the material "on hand," is a large quantity of tubular stone-ware drain pipes and junction blocks, indented for from England, and involving, up to the end of April, an outlay of Rupees 53,517-2-4. A further quantity is now in the course of shipment, and the whole will amount to about Rupees 70,000. These stone-ware pipes and blocks vary in dimensions from 4 to 12 inches, and will be required to construct minor street drains, as well as for connecting the surface drains, and those from private houses and compounds, with the Sewers. The quantity indented for is sufficient to bring a considerable portion of the

area within reasonable distance of the Dhurrumtollah Main Sewer, and the branches in Old Court House Street and Chowringhee Road into practical drainage. A portion of the cost of such pipes will be recovered from house-owners as soon as the provision of the Act, rendering the connection of private house drainage with the public Sewers compulsory, is to be enforced. The cost of laying these drain pipes will be very small, and this can be done during the rainy season, when the more important works must necessarily suffer some interruption.

15. We likewise have, at the present moment, a supply of not less than 80 lakhs of very superior bricks, and had the preliminary rains not set in with such violence, we should, in all probability, have had 10 lakhs more. This supply is calculated to enable us to complete the remaining portion of the Dhurrumtollah Main Sewer and its two branches, to construct the great Receiver at Entally, as well as the buildings in connection with the temporary Pumping Station, and to erect the work-shops required to replace those at the Balliaghatta Depôt, which latter will have to be given up to the Mutlah Railway Company. Thus, the Experimental Works, as far as the main object is concerned, might be put to practical test by the end of the current year, the temporary pumping into the old cess-pool, at the head of the Balliaghatta Canal, of sewage matter *to no greater extent than at present finds its way there*, though in a greatly more diluted

form, being conceded. If, on the other hand, this important test is to be delayed until the high level Sewer to Tengrah Creek is constructed, very considerable time must elapse, and several more lakhs of Rupees borrowed and spent, though in that case the works cannot any longer be called "experimental," as they will comprise that part of the scheme which provides for the final removal of the *whole sewage of this Town* from its concentrating point, the great Receiver at Entally.

16. Our Engineer has detailed in his Report the machinery which has been fixed at Kootrung, and which we have had the satisfaction of showing to your Honor in full work; we have therefore only to specify that which is used at Calcutta in connection with the works in progress. It comprises—

A 10 H.-P. portable Steam Engine.
A 7 „ ditto ditto.
A Weigh-bridge.
Two Centrifugal Pumps.
A Rotary Pumps.
A Piling Engine.
Two Portable Cranes.
Two Mortar-mixing Machines.
Six 18-inch Pulley Wheels and Hooks.
A 20 H.-P. Engine for the temporary Pumping Station.

In addition to the above, the following machinery is on its way out from England, *viz.*:—

Five patent double-acting Centrifugal Pumps, with pipes, &c., complete.

Two Soorkey Mills.
Shafting.
A patent Chain Pump, complete.
A 10 H.-P. Portable Engine, together with a number of implements required for the work-shops.

17. The temporary Pumping Station at Entally, for which the financial means have lately been obtained, is now in the course of construction, and arrangements have been made for fixing the lifting engine without delay. Every thing has therefore so far advanced as to bring the Experimental Works by the end of the current year to completion.

18. We fear that, with regard to the extent of the works actually required to be completed, so as to bring the experiment to a practical test, some misapprehension exists. The Drainage Committee recommended for that purpose the construction of one of the Main Sewers either down Dhurrumtollah or Colootollah Street, with its collateral branches or minor drains, but made no provision for the high level Sewer or for the out-fall at Tengrah Creek, which will be a work of great magnitude, and, indeed, among all the objections which have been raised against the present scheme, the efficiency of the Pumping Station and of the high level Sewer, has never been questioned. Whatever alterations have been proposed each and all provided for the pumping up of the sewage matter from the first incline to the second, and conveying it through either covered or open Sewers in the

Reservoirs to its final outlet. This part of the scheme appears to have been recognized as perfectly sound and free from all doubt and objection by all, and therefore requires no experiment. The point, however, on which some doubts existed, and which the practical experiment was to solve was, whether in the absence of a regular and diffused system of water-supply all over the Town, the artificial flush from the river was sufficient to ensure the proper action of the Sewers in a manner so as to convey the sewage matter within the operation of the Pumping Station, and allowing of its being pumped up into the high level Sewer. To give this experiment a fair trial, the Dhurrumtollah line was selected for the first main Sewer, owing to the presence of the Chandpaul Ghaut Engine close to the upper invert, and the Branch Sewers were constructed in Old Court House Street and Chowringhee Road, because the necessary amount of artificial flush could be secured by means of the existing aqueducts. In these streets, moreover, the whole of the surface drains might be brought into connection, and the private drainage of many houses might, with perfect safety, be connected with the public Sewers. There is not the least occasion to construct, for the sake of the present authorised experiment, a larger number of collateral and surface drains, for the principle will be throughout the same, and the result must likewise be the same, whether the experiment is extended to twenty or limited to

two collateral Sewers. For this purpose, therefore, we would again urge, that the construction of the high level Sewer to Tengrah, which, with the land that has to be purchased, and the construction of the permanent Pumping Station, with duplicate machinery, is estimated to cost about *five* lakhs of Rupees, is not at all necessary for the immediate purposes of the enquiry into the efficiency or otherwise of the system proposed to be carried out by Mr Clark and the Drainage Committee.

19. There is also another point, which must not be lost sight of. In all the schemes which have, for the last twenty-five years, been brought before the public, an ample supply of water throughout the Town was considered an indispensable adjunct to any new system of Drainage. The late Colonel Forbes, Mr. Simms, Mr. Clark, Mr. Rendell, Mr. Longridge, in fact every one who studied the subject, always considered an abundant supply as the very *sine quâ non* of the efficient action of the Sewers, and indeed this point has very frequently been dwelt upon by us in the recent correspondence with Government. At the same time it was argued that, wherever artificial flush can be secured, no apprehensions about the proper action of the Sewers need be entertained. This, therefore, is the main question which the Experimental Works are to solve, and for that purpose, as already stated, the main Sewer and its branches have

been constructed in localities where such artificial flush is at hand.

20. From what we have stated above, it will, we trust, be admitted, that in order to give the Experimental Works, and, in fact, the whole scheme, a fair test, the course we have adopted is quite sufficient for every practical purpose. These Experimental Works consist only of a fraction of the total undertaking, and surely they do not necessitate the construction of the expensive high level Sewer which will be required to convey the sewage of the *whole* Town to its final out-fall, but which, after all, is not intended to afford a proof of the success of the scheme, and therefore would for some time have only to carry off a small portion of the Town sewage, which at present finds its way into the Canal.

21. The idea of pumping the whole of the sewage of the Town into a Canal navigated by boats carrying on a very extensive traffic, is undoubtedly opposed to all principles of sanitary rules; but this is not intended. A calm consideration, however, of the effects likely to result from all that is now contemplated by our Experimental Works, will at once dispense all apprehensions. The points requiring to be considered are:—

1*st.*—What is the nature of the sewage matter proposed to be pumped into the Canal?

2*nd*.—The quantity of sewage thus disposed ?

3*rd*.—Whether the voidance of such sewage into the Canal is likely to produce worse effects than the present out-flow into the same receptacle ?

4*th*.—The period for which it is intended to make the Canal the receptacle of such sewage ?

22. With regard to the first question, we may observe that, as the connection of private drainage from houses with the public Sewers would be limited to only such premises as command an abundant supply of water, the amount of sewage thus finding its way into the public Sewer would be very limited. We believe that most houses in Chowringhee Road and Old Court House Street would be able to connect their private drainage with the public Sewer, but such will, for the present, remain optional with the owners, who have to bear the expense thereof. In Dhurrumtollah there will certainly be but few disposed to incur the outlay, but, under any circumstances, none will attempt to do so, unless they have a command of a sufficient supply of water, to ensure the proper action of the private house drains. The sewage of houses therefore will reach the public Sewer in a diluted form already, and if to this be added the flush which the Sewers are to receive from the river by means of the Chandpaul Ghaut Engine and the aqueducts, and the further

dilution which such process must produce, the sewage will reach the Canal in an infinitely less offensive form than the discharge of the present Dhurrumtollah drain creates, and, moreover, it will become at the moment of its voidance mixed up with such a volume of water as to be perfectly harmless. The same remarks will equally apply to question No. 3.

23. The next question is as to quantity. As already stated, the sewage which it is proposed to pump into the Canal as a temporary measure only, will be precisely the same as at present finds its way there, but under very different circumstances. Instead of being allowed to accumulate and stagnate in the great cess-pool, until washed by a heavy rainfall into the Canal, it will be pumped in daily in comparatively small quantities, and so much diluted with the water of the sub-soil and that of the artificial flush, as to become almost perfectly innocuous, and if really any nuisance could be caused thereby, it would be only an infinitesimal portion of that created by the present cess-pool at certain periods of the year. An inspection of the matter in this part of the Canal during the whole of the past hot weather was quite sufficient to carry conviction in the mind of any unprejudiced person.

24. But supposing even that the very worst anticipations regarding the injurious effects resulting

from pumping this very small quantity of the sewage into the Canal were realized, what would the real extent of the evil amount to? Now, it must be obvious that to test practically the efficiency of the main Sewer, its two branches and of such surface and private compound drainage as may be connected with them, it requires neither a year nor a month; eight days' trial will afford all the test that may be necessary, and therefore the pumping into the Canal would be for a limited period only. If during that time no ill effects arose from this measure, no reasonable objection could be raised to continuing pumping the sewage into the Canal, until the high level Sewer can be constructed. If, on the other, any ill effects really occur, not only must the pumping into the Canal, but even the use of the Sewers themselves be discontinued till the high level Sewer may be completed. By these means the cost of constructing this latter would be obviated, until the efficiency of the works now in the course of construction was practically proved. No inconvenience could arise from the temporary stoppage of using the Sewers pending the completion of the high level Sewer, as private drainage would at first be limited to the connection of the compound drainage with the public Sewer, the old or existing drainage being retained in the meantime.

25. There is only one other point which requires explanation. It may be argued that, considering the

limited use which will be made of the temporary Pumping Station, it is not consistent with due economy to expend money for its erection. The fact is that though called "temporary," it is only so as far as the pumping into the Canal is concerned, but the engine itself is intended to be permanent, as it will be wanted for the working of the machinery in the work-shops, which must be erected for replacing those at the Balliaghatta Depôt, which, under the orders of Government, will be taken over by the Mutlah Railway Company; and we do not think that a better and more convenient locality could be selected for that purpose.

26. In conclusion, we deem it but an act of justice to reiterate our hearty approval of the indefatigable, and, we believe, the successful exertions of our able Engineer, Mr. Clark, whose energy and spirit is untiring, as his skill and ability is competent to master the arduous undertaking on which he is engaged, and we cannot show our estimation of this excellent public servant better, than by quoting the words recently published in an English public journal respecting him to the following effect:—

"The Hull Advertiser."

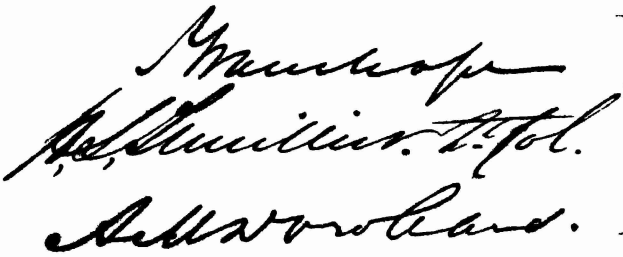
"It was an evil day for Hull when we lost Mr. Clark. He was by far the best Engineer we have ever had, and had he remained with us, Hull would have been ere this the best drained town in the kingdom. Since he left us all has been going wrong."

We firmly believe that Mr. Clark has proved himself the right man in the right place, as regards the City of Calcutta.

We have the honor to be,

HON'BLE SIR,

Your most obedient servants,



Municipal Commissioners.

APPENDIX A.

DRAINAGE REPORT.

By the Engineer to the Commissioners.

Dated 20th May 1861.

1. In compliance with the orders of the Commissioners, I have the honor to report the progress which has been made with the Drainage Works since March 1858, the date of their last Report to Government.

2. In conformity with the orders of Government conveyed in the letter No. 1199 of 10th June 1857, the preliminary arrangements for securing supplies of material were then being made.

The Chur at Kotrung had been obtained, and orders had been sent to England for the machinery, &c., required for the manufacture of bricks, soorky, &c., &c., and such further implements as would be required in Calcutta at the commencement of the works, when orders to that effect should be received from Government.

The requisite process for obtaining a portion of the high land, comprising 84 beegahs, was in progress.

By the end of May following 88 lakhs of bricks had been made, and the plans, &c., prepared for the erection of the requisite buildings at Kotrung.

3. About this time, in accordance with the recommendation of the Drainage Committee of 1856-57, a series of tidal observations were commenced, for recording the heights of

the water simultaneously, at Chitpore, Dhappa, Bammonghatta, Tengrah, Tolly's Nullah, and Chandpal Ghât.

These observations were continued from the beginning of March 1858 to the end of March 1859.

They are recorded in the Office, and are most valuable now in determining the relative levels of the water in the various localities where they were taken, as affecting the important question of the out-fall of the Drainage.

4. In April 1858 the Commissioners received a letter, No. 1005 of 30th March, from the Government of Bengal, suggesting that the whole scheme for the Drainage of Calcutta, as approved by the Drainage Committee, (whose Report was submitted to Government in June 1857,) should be referred to some Engineer of eminence in England, for report.

Mr. M. Rendel (son of the late eminent Engineer of that name) happened to be in India on Railway business, and the opportunity appeared to be favorable for obtaining the required opinion.

5. With the sanction of Government the case was submitted to that gentleman, with the hope and expectation that, being on the spot, any delay in furnishing the Report would be unnecessary.

Mr. Rendel was unable to give his opinion in the short interval before his departure for England (on the 8th May 1858,) and his Report, dated 12th November of that year, was received at the end of December following. By the orders of the Commissioners, I had the honor to submit my remarks on Mr. Rendel's Report on the 26th January 1859.

I differed from Mr. Rendel entirely.

These documents have been submitted to Government, and it is therefore unnecessary that I should further allude to them.

6. It was with great satisfaction that I found my views, on a question of such vital importance to every indivi-

dual among the 500,000 inhabitants of this great City, had been so far adopted by the Commissioners and Government, as to bring about the actual commencement of the works, the order for which was conveyed to me on the 20th April 1859.

7. The interval between March 1858 and April 1859 was principally devoted to the manufacture of bricks, and the perfecting of the arrangements which are intended to supply materials for the whole of the works connected with the Drainage of Calcutta.

8. The works at Kotrung consisted in the erection of buildings and machinery, the construction of tramways, ghâts, &c.

The buildings which are completed comprise:—

An engine house, with large water-tank above.

A boiler house.

Two machine sheds.

A chimney, 83 feet high.

A soorky mill-house.

Six sheds for drying bricks.

Two work-shops.

A 3-roomed bungalow for Engineer, &c.

A ditto ditto Superintendent of the Works.

A 2-roomed ditto for Assistant.

A bridge over the canal.

A shop for sale of stores to coolies.

Six ranges of coolies' barracks of kutcha-pucka work.

9. The usual difficulties were experienced in obtaining the necessary artificers, and progress was slow; but so much was done as enabled the actual Drainage Works to be commenced a year afterwards with abundance of material of a very superior quality.

Large quantities of material, averaging 60 tons daily, are now regularly despatched in the Commissioners' and other boats, for the Calcutta Works.

10. The actual cost in labor of erecting the buildings has been Rupees 23,124-12-11, to this the cost of the bricks, lime, soorky, and timber, must be added, bringing up the total amount to Rupees 55,003-2-11, a sum which I believe they will considerably more than realize, when no longer required for Municipal purposes.

11. There is a peculiarity in the construction of these buildings, which it may not be here out of place to notice, as it is my conscientious belief that it may, and will eventually, be extended with great benefit to the erection of buildings throughout India, as it reduces the first cost and after repairs, and entirely obviates the necessity for the use of timber.

It had long been a subject of thought with me to devise some plan by which brick arches could be made to cover buildings, and supported by walls of the ordinary thickness as built in this country.

What I desired was to devise some means whereby a continuous resistance could be given to the thrust of arches *built with ordinary materials*, and covering a long building; something which should, in fact, supply the place of the abutments of the arch, giving it the requisite stability, *however small the rise of the arch* as compared with the *span* might be.

I have succeeded in my endeavors.

12. As the Commissioners are aware, an arch 38 feet span has now been standing a year with perfect stability. Its rise is 6 feet, thickness 10 inches, and the supporting walls 20 inches in thickness only.

13. A first experiment on a small scale was so successful that I proposed to the sitting Commissioner, Mr. Dowleans,

to cover a building then in course of erection, with the understanding that in case of failure, the expenses incurred should be borne by myself.

This succeeded: the smith's shop, 110 feet long, was covered with an arch 5 inches in thickness, 18-4 span, and 6 feet rise.

14. By careful personal attention to the details of this construction, I derived the experience which enabled me to simplify and economise the expense in labor necessarily attendant on giving an arched form to so small a quantity of material as that contained in an arch 5 inches in thickness; and I was emboldened to propose, with a similar understanding as in the above case, that the bungalow (the walls of which were at that time built up) should be covered with arches 2 feet 4 inches rise only, the span being 16 feet 6 inches.

This also succeeded, and eventually all the buildings not previously roofed have been covered in the same way.

At Kotrung the area thus covered amounts to 20,873 feet superficial.

15. Buildings have before been covered with arches, and arches have been tied with iron rods, but the principle involved in the details of this plan, on which its general and economical application alike depend, I believe to be new, and I was thus enabled to bring it into practical use. I have no hesitation in saying that, as compared with the ordinary mode of covering permanent buildings in this country, an economy of not less than Rupees 8,000 has resulted in the constructions that have been put up at Kotrung.

16. I have thus at some length noticed the introduction of this principle of constructing roofs. I have done so, because it has emanated from works connected with the Drainage of Calcutta, and because I consider it to be a

subject of public interest, as it admits of buildings being erected without the aid of timber, and extends the use of materials available in almost every part of the country, and by such simple means as may be easily accomplished by native artizans.

17. I have also considered it desirable to explain that I have not heedlessly experimented with the funds entrusted to me, and I have to thank the Commissioners for the opportunity afforded me for giving a proof so extensive and practical of the advantages of the principle.

18. The machinery ordered from England for Kotrung has all been erected; it consists of

A steam engine 25-H.-P., nominal.
Two 25-H.-P. boilers.
Two soorky mills.
Six brick-making machines and pug mill.
A circular saw table.
Screw-cutting, self-acting slide lathe.

} The Engine is capable of working all these machines.

One portable weighing machine.
One pump.
One timber jack.
One crab, double purchase.

19. At the end of 1859, when the buildings were well advanced, the former Superintendent resigned his appointment, and the engine, machines, &c., have, for the most part, been erected by the present Superintendent, Mr. Leeming.

20. The engine is a good substantial article, supplied at a very reasonable rate by Messrs. J. Wilson and Co., of Hull, for £610 inclusive of two 25-H.-P. boilers.

The latter unfortunately sunk in the river after arriving in this country—one only was recovered; it became necessary to replace the lost one by another, which was also obtained from England.

21. The two soorky mills were also supplied by Messrs. J. Wilson. Repairs have been required to one, in consequence of the breaking of the centre spindle; in all other respects their working has been highly satisfactory: when in full work they are capable of producing 100 maunds per hour, and have done so with great regularity when required.

The consumption of soorky has been very great, and when the works are proceeding with vigor, they have only barely sufficed to meet the demand.

Any breakage under such circumstances would lead to a stoppage of the works; an additional pair of mills have therefore been ordered, which will be fixed in connexion with the temporary engine about to be erected near the cess-pool at the end of Balliaghatta Canal.

22. The brick machines are by three different makers, three by Whitehead, two by Clayton, and one by Bradley and Craven; of these, the last is the one to which I give the preference; it makes, when at work, with great regularity, 6,000 bricks per day, of a quality as near perfection as can be desired; Clayton's and Whitehead's machines *cut* the bricks, Bradley and Craven's *moulds* them; Clayton's machines produce excellent bricks, about 8,000 to 10,000 per day each, when well tended, but there are more wasters.

The same remarks apply to the other three machines by Whitehead.

All are capable of producing very superior bricks to those made by hand. The quality is more uniform, resulting from the pugging of the clay; they are harder and more dense when burned, in consequence of the pressure to which they are subjected in the process of making; for these reasons the materials made by them are to be preferred for Drainage Works. The cost is somewhat greater than that

of hand-made bricks, but the superior quality amply repays the difference.

23. As the bricks are made by the machine, they are placed on endless bands, kept in motion by the engine, and by these means are carried to a distance of 230 feet if necessary, but they may be taken up at any point within that distance and stacked for drying, either within or outside the sheds, according to the season of the year and state of the weather.

Under the floor of the brick sheds, flues have been constructed, into which the waste steam from the engine is admitted. By the heat thus obtained the bricks may be dried, even during the rainy season, with great rapidity.

Each of the six sheds is capable of holding about 75,000 bricks, so that at the end of the rainy season 4½ lakhs of bricks ought to be ready for burning.

24. I consider there are several advantages attending the machines, in addition to the superior quality of the bricks: amongst these I may mention the following. By their use, bricks of any required shape may be made throughout the year.

A larger *quantity* ought thus to be obtained annually. The space required is comparatively small, as the bricks, when made, being firm, can at once be put into walls or hacks for drying, which is rapidly effected as above described.

They may be worked by coolies, who will not attempt to make bricks by hand, but in order to work them with the greatest advantage, the skill acquired by practice is still necessary, and the constant changes among the men employed is one of the greatest difficulties to be contended with: could this in any way be prevented, a much better result would be obtained.

25. The great demand for coolies on the Railway and other works in the neighborhood of Calcutta has made it very difficult to procure the required number at Kotrung, even for the work to which they are most accustomed, *viz.* the cutting and carrying of earth; for the want of the means of cutting and carrying the mud from the pits to the machines, frequently all the machines have been stopped, and generally two only of the six have been kept in operation.

Every reasonable inducement has failed at present to increase the number of coolies.

Excellent barracks, capable of lodging 5 or 600, have been built for them; a shop for the sale of provisions, where just weights and measures are ensured, has been built; those who are regularly employed receive subsistence money in case of sickness: all obtain medicine when required.

The rates for contract work, and daily wages, are liberal and regularly paid, and I do not consider it desirable to increase them. I hope that the above inducements, with constant employment, may eventually secure the labor we require.

The average daily numbers employed at present are as follows: artizans 90, coolies 340.

26. The land at Kotrung is admirably adapted, both in position, and for the material it furnishes, for the manufacture of bricks for the Drainage Works.

The quality of the bricks is all that can be desired, when proper care and management is observed in the burning, and removal to Calcutta.

27. The distance just enables the boatmen to load their boats, unload them in Calcutta, and return the same day. Any increase to this distance, or any want of facilities in the loading and unloading, which would prevent the return on

the same day, would not only double the cost of transit, but would give great difficulties in procuring men.

Were it necessary to enter the Canal to unload the boats, as I believe has been suggested, in preference to the use of Mullick's Ghât as at present, I believe that the cost of bringing the material would not only be three times what it now is, but would so increase the difficulty of obtaining boatmen, that a serious obstacle would thereby be presented to the progess of the works.

28. After much difficulty the co-operation of the brick merchants in the vicinity of the Chur was obtained, for the supply of boats and men. As removed by them, the cost is 1 Rupee 8 annas per 1,000 bricks.

Five boats, capable of carrying 2,500 bricks each, have been built at Kotrung, at an average cost of Rupees 310-8 each; these are let out under agreement to contractors, who supply the men, and under these circumstances 1 Rupee 6 annas per 1,000 bricks is the rate paid.

29. In order to facilitate and economise labor, 6,000 feet of tramway has been laid, for the purpose of conveying mud, bricks, coals, soorky, &c., to and from the machines, to the river bank, and other places, where required.

Forty trucks have been built, at an average cost of Rupees 80 each, and are now in constant use for the above purposes. A pony can draw loads of 1 ton on the tramway with ease: 5 ponies, costing Rupees 30 each, are so employed.

30. The encroachment of the river upon the Chur land has been rapid. Previous to the rainy season of 1860 it became absolutely necessary to take some measures for its protection.

The 'bore' strikes with great violence on the Chur. To prevent the effects of this, in removing the soft soil of which

the Chur is composed, a large groin was constructed, with trees, stone ballast, and all the ponderable substances that could be obtained.

With some difficulty this groin was completed, and it now forms a valuable addition to the works in the form of a jetty projecting well out into the river, from which boats can be loaded from the tramway trucks, with great expedition, and it effectually screens the land behind it from the scouring action of the 'bore.'

31. The saw-mill has been of great service at Kotrung. Till it could be got to work, sawyers, though urgently wanted, were not procurable. No difficulty is now experienced in this way, but care is necessary to prevent injury to the saw by those whose work it now performs with expedition and economy.

32. A self-acting lathe was purchased in Calcutta.

It is a very useful addition; by its use repairs to the engine and machinery can be effected by the establishment, which would otherwise be expensievly executed in Calcutta.

BALLIAGHATTA DEPOT.

33. The purchase of 2 beegahs 17 cottahs 11 chittacks and 1 kutcha of land from Mr. Fraser, for Rupees 4,551, was mentioned in the last Report.

Three sheds, each 64 feet long, were first constructed, and subsequently four other sheds, with arched roofs.

The land was enclosed on two sides where the protection was required by brick walls, one of which is composed principally of short portions or patterns of all the sewers which it is proposed to construct in the Drainage Works.

The whole now forms a valuable block of buildings, used as a General Depôt for timber and other materials, as well

as for work-shops, where all the implements required for the works are made and repaired.

34. Unfortunately, however, just when the buildings were completed, notice was received that the whole of the land and premises would be required for the purposes of the Mutlah Railway, and it will be necessary to remove as soon as another suitable site can be obtained for the purpose.

The Commissioners have applied to Government to put them in possession of an equal area of ground in a convenient situation.

The cost of the buildings will, of course, be refunded to the Commissioners, amounting to Rupees 11,243-0-1.

35. The following implements, among innumerable smaller matters, have been made at the Balliaghatta Shops:—

List of Miscellaneous Tools at the C. M. C. Depôt, Balliaghatta, 20th May 1861.

Number.	Description.	Number.	Description.
	No. 1 Sewer.		No. 3 Sewer.
1	Centre, complete, minus Lagings.	3	Centres, complete, 12 feet long.
1	Manhole ditto, complete.	2	Curved ditto, 40 feet, radius 6 feet.
1	Leading Template.	6	Leading Templates.
2	Inner ditto.	4	Inner ditto.
		1	Block ditto.
	No. 2 Sewer.		No. 4 Sewer.
7	Centres, complete, 12 feet long.	3	Centres, complete, 12 feet long.
8	Centres, ditto, minus Lagings.	1	Curved ditto, 40 feet, radius 6 feet.
1	Tunelling ditto, ditto, 7 feet.	8	Leading Templates.
3	Manhole ditto, ditto.	3	Block ditto.
1	Junction ditto, ditto, with 2 sets of ribs, right and left.	5	Inner ditto.
			No. 5 Sewer.
15	Leading Templates.	4	Centres, complete (out).
9	Inner ditto.	5	Leading Templates (3 out).
2	Ditto ditto for inlet sewer.	6	Inner ditto (all out).
14	Block Templates.	3	Block ditto (2 out).

List of Miscellaneous Tools at the C. M. C. Depôt, Balliaghatta, 20th May 1861.—(Continued.)

Number.	Description.
	No. 6 Sewer.
3	Centres, complete, 12 feet long.
1	Curved ditto, 40 feet, radius 6 feet.
1	Manhole ditto, complete, 8 feet.
5	Leading Templates.
4	Inner ditto.
4	Block ditto.
	No. 7 Sewer.
4	Centres, complete, 12 feet long.
1	Centre, ditto, 6 feet long.
1	Curved ditto, 40 feet, radius 6 feet.
1	Manhole ditto.
1	Junction centre of No. 7×8
5	Leading Templates.
5	Inner ditto.
5	Block ditto.
	No. 8 Sewer.
4	Centres, complete, 12 feet long.
2	Manhole ditto.
1	Curved ditto, 40 feet, radius 6 feet.
5	Leading Templates.
5	Inner ditto.
4	Block ditto.
	No. 9 Sewer.
3	Centres, complete, 12 feet long.
1	Curved ditto, 20 feet radius.
1	Manhole ditto, complete.
1	Junction ditto, ditto, of No. 8×9.
4	Leading Templates.
5	Inner ditto.
2	Block ditto.
	No. 10 Sewer.
2	Centres, complete, 12 feet long.
2	Curved ditto, 20 feet radius.
2	Manhole ditto, complete.
4	Leading Templates.
2	Block ditto.

Number.	Description.
	For Out-let Sewer.
1	Large Centre, 20 feet, complete.
1	Culvert Centre, ditto.
4	Culvert Templates.
8	Invert ditto.
2	Roof Centres (one large).
1	Door ditto.
3	Gully Templates.
4	Side-entrance ditto.
	TOTAL.
72	Centres.
53	Leading Templates.
47	Inner ditto.
40	Block ditto.
27	Pairs of Roller Frames, fitted with rollers.
68	Sets of Roller Frames.
16	Pile Engines (6 out).
10	Monkeys, complete (6 out).
7	Ditto unfinished (1 out).
14	Mouth Piece Water Shoots.
36	Water Shoots (20 out).
26	Windlasses, complete.
6	Ditto, unfinished.
81	Tagurs (25 out).
30	Squares, of different sizes.
41	Straight Edges, ditto.
36	Wheel Barrows (11 unfinished).
34	Portable Offices (3 out, one-half finished).
132	Pieces of Block Mould (22 out).
120	Brick Moulds.
30	Mallets.
3	Pairs of doors and windows.
4	Ladders (1 out).
6	Soorkey sieves (4 out).
5	Plum bob Straight Edges.
10	Farahs.
47	Ranging Rods.
14	Water Buckets.
14	Mortar ditto.
110	Pieces of Soondry Posts, 6 feet.
80	Soondry for Rails.
6	Railway Trucks, 2 complete.
5	Bricklayer's Level.
1	Frame for Out-let Sewer Centre.

CHOWRINGHEE ROAD FOOT-PATH.

36. During the interval, while the Drainage Report was with Mr. Rendel, the first Foot-path in Calcutta was constructed.

The open sewer which formerly ran along the east side of the Chowringhee Road was covered over with a brick arch, and a pathway made over it, extending into the road for an average width of 20 feet.

The total length is 8,770 feet.

The total quantity of soil, ballast, &c., required for making this pathway, may be estimated at 200,000 cubic feet, and its weight at upwards of 8,000 tons.

A large portion of this was led by the conservancy carts. The total cost of the Foot-path was Rupees 11,179-3-9, including the channel stone.

37. Very considerable differences of opinion were entertained regarding the path.

It was contended that the natives would never use it when completed; experience has proved that they do use it, as I believe they would do any other arrangement which tended to their comfort and safety, without entailing expense.

The time occupied in completing it was considerable, and this is explained by the large quantity of material required.

38. The Chowringhee Road Foot-path was the first attempt at introducing that common accessory to the safety of foot-passengers in Calcutta, and may be considered as worthy of passing notice in this Report.

Its construction was necessary as a protection to the gas pillars, which are placed just within the kerb stone.

DRAINAGE WORKS.

DHURRUMTOLLAH MAIN SEWER.

39. The order to commence the works for the Drainage of Calcutta was conveyed to me on the 20th April 1859.

The Dhurrumtollah Main Sewer was selected as the first to be constructed.

The internal dimensions of this sewer are 8 feet 1½ inches high, by 6 feet 3 inches wide, of an egg shape, and giving an internal capacity equal to a circle 7 feet in diameter.

The inclination or fall of the sewer is 4 feet per mile.

Thickness of the brick-work 1 foot 9 inches.

The depth of excavation varied very slightly from one end to the other, averaging 16½ feet.

40. This being one of the deepest works of the whole scheme, and the ground untried, I determined to sink trial shafts or wells 6 feet diameter, at intervals of 1,400 to 1,500 feet, for the purpose of ascertaining the nature of the ground.

These wells were also intended as starting places for the sewer works, and to collect the sub-soil drainage water from the sewer as the works progressed. By sinking them somewhat lower than the depth of the sewer, it was also intended to drain the ground below the required depth of the excavations, and thereby facilitate the work; in some instances this was successfully accomplished.

41. The plan adopted for sinking the wells was the one ordinarily adopted in this country, of building upon a circular frame of timber, and sinking it by excavating from the interior.

It was, however, soon discovered that this arrangement would not answer without some additional precautions in the ground we had to deal with; and subsequently all the

wells were strengthened by inserting timber rings at intervals of 8 feet, and tying them together by vertical bolts extending through the brick-work, the bricks being all cut to fit the radiating form required, and notched to receive the iron bolts.

By this plan the cylindrical brick linings of the wells were enabled to bear the unequal strains and settlements to which they were exposed.

42. Little trouble was experienced with No. 1 well in the Circular Road; it was sunk to a depth of 25 feet by the middle of July.

43. No. 2 well was situated in a narrow part of Dhurrumtollah street, near the end of St. James' lane.

To the depth of 13 feet it was sunk through a sandy soil, with comparatively little water, at that, the driest season of the year, *May;* at a depth of 13 feet, and 3 feet above where the brick-work of the sewer was to be commenced, a soft stratum was reached, and promised to give the very considerable difficulties which were afterwards encountered.

From this depth, 13 feet, the well commenced to sink by its own weight, and at least 10 feet were afterwards added at the top, which sunk as it was built; while the depth of the interior, though continually excavated, did not increase. The soil was a thin silt, into which buckets were dipped as the only means of removing it.

44. After fruitless endeavors of this nature, it was determined to abandon the well for a time, to allow the silt within it to consolidate; it then rose to 9 feet from the surface, and in a short time became quite hard; in the mean time a floor was prepared to fit the inside, composed of thick planks, with a hole 1 foot square in the middle, to allow of the soil being excavated from beneath, as was eventually done.

When the work was resumed, it was found that the upper 4 or 5 feet of mud in the well had become quite hard; this was removed, and on the first appearance of the silt below, the floor was laid in the well and sunk to a depth of 16 feet, by forcing it down with struts and wedges from the top.

At that depth the workmen incautiously left the small hole above alluded to open when the day's operations were finished; and the following morning the well was found again to be filled with thin mud to a depth of 8 or 9 feet.

45. Without further delaying the works on account of this well, it was determined for a time to abandon it. As, however, it was useless for the purposes of pumping from, a subsequent attempt was made to sink it, as before. It was found that at the top the silt had become quite hard, and for a foot or two below the floor, which was sunk as the excavation proceeded. Suddenly, however, the mud rose again with such violence as to drive the people out of the well; and it was not till a fourth attempt was made that the floor was secured in its place, at about 17 feet from the surface, after a quantity of mud, represented by six or seven times the cubic capacity of the well, had been removed from it.

This was not a promising trial for the future operations, and I have explained it at this length, in order that the difficulty and expense of the after operations may be better understood and accounted for.

46. No. 3 well was sunk at the south-west corner of Wellington Square. Immense quantities of water were met with in sinking this well; and at the depth of 20 feet the same soft stratum as at No. 2 was pierced; a floor was put in by similar means to that formerly described, but with less difficulty.

47. No. 4 well was sunk immediately opposite the entrance to the Native Hospital compound.

Immediately under the road metal, 3 feet in thickness, the ground was found to be a perfect quicksand, from which,

if a kodaleeful of sand were taken, the next instant the depression could not be seen: the entire depth was of a similar character. An immense quantity of water was pumped from this well as it sunk, and had the effect of drying the ground very considerably; but the wet silty nature of the ground afterwards gave great trouble in this locality.

48. No. 5 well was sunk opposite Mountain's Hotel, in Esplanade Row.

No. 6, east of the gun-platform in Government House compound.

No. 7, near the Town Hall.

These were all timbered wells, as being cheaper; the ground in all cases being similar, a light sandy loam, with layers of sand and large quantities of water.

It will be seen from the foregoing that the difficulty to be contended with in constructing the Main Sewer through Dhurrumtollah, promised to be considerable, and such they afterwards proved to be.

The wells were successively commenced as work-people could be procured.

49. The first block of the Sewer was laid by the President, on the 8th of August 1859, and the works were steadily persevered in during the whole of the rainy season of that year.

The peculiar nature of the ground at well No. 2, as might be expected, gave me great anxiety; a week of hard labor was sometimes spent in a fruitless endeavor to get in one 12 foot length: portions of the work in that locality have cost Rupees 30 per foot forward for labor alone, while in a few other places it has been executed for Rupees 6.

50. I found it to be absolutely necessary that my personal supervision should be given to the work: at that time I had not one Assistant experienced in such undertakings; most of them knew nothing whatever, and have been taught.

51. The laborers exhibited all their usual indifference, and often have left the work at the precise minute for their dismissal, which no inducement could prevent, though the entire day's labor was sacrificed, and considerable danger to the adjacent buildings incurred by the insecurity of the timbering, which an hour would suffice to overcome.

I have several times been thus left with only the aid which two or three such Assistants as the above could render, and I may now candidly state, that I have often felt that the work I had in hand, with the means that were available, was an impossibility.

52. The soft stratum to which I alluded above, when met with in the excavations for the Sewers, was the principal cause of the difficulty experienced. The usual expedient of caulking in between the piles with straw, was quite insufficient to keep back the fluid mud; it burst in, in all directions, and rose from the bottom as rapidly as it could be removed.

It was this latter circumstance that enabled me at last to succeed: had the large brick blocks *sunk* into the mud, it would have been necessary to excavate to a greater depth, and build a platform whereon to commence the Sewer, and this for a short length was done; but I found the upward pressure was so great, that if the bottom of the Sewer could be got in, and part of the side walls, without a cessation of the work, all the sides being carefully filled up solid, that there would be a balance between the weight and the upward pressure, and the work would stand firm; upon one occasion a course of thirty-five blocks, each weighing 200 lbs., covering an area of 60 superficial feet, rose up 1 foot during a night. Remembering also that the actual weight of the mud removed from the excavations greatly exceeded the weight of the brick-work afterwards put in, I was induced to try the effect of laying the bottom of the Sewer without the expense of a platform; my expectations were correct,

and have since been verified, the Sewer has stood remarkably well: when a portion has been removed to ascertain the nature of the ground below the blocks, it has been found, as it was in well No. 2, after a time, quite hard.

Had it proved to be necessary to lay a platform in such places, it would have increased very considerably the already heavy cost of the work.

53. Great difficulty was experienced also in obtaining a sufficient number of work-people; about Christmas 1859 they had become so few, that at one or two places the work was stopped.

In this state of things a European offered to take the work by contract, and to bring European sailors to execute it. I agreed to this, and though I found the work was not so well done, the expense, and destruction of implements, considerably more than while natives were employed, yet the attempt was successful, as it had the effect of bringing more natives on to the works.

54. I afterwards also obtained contractors at other portions for the labor only, but they had the same difficulties in obtaining work-people: close superintendence was equally necessary, and the work was not so well done.

55. The excavations in Government House compound were commenced near the gun in the centre; this was let to a European contractor: the ground proved to be good, but the quantity of water was very great.

An attempt on the part of the contractor to save the expense of timbering the excavations, caused a serious slip near the south-west front of the House, fortunately on the side opposite to the building. To prevent further mischief of this kind, I took the work into my own hands, and then abandoned the contract system.

56. The Sewer was constructed under the platform on which the gun stands, by tunnelling, the gun itself having been previously removed.

The excavations were made within a few feet of the southern front of Government House with perfect success. I believe up to this date not the slightest settlement has taken place in the building.

When the outlet of the *system* is opened, and the Sewer kept free from the sub-soil drainage water which now accumulates in it, I have no doubt that this building, which shows every indication of damp in the lower apartments, will become perfectly dry, from the proximity of this large Sewer, laid some 8 to 10 feet deeper than the foundation.

57. The direct line of the works carried the Sewer under the arched entrances to Government House compound. I had considerable anxiety regarding these constructions, which are of a very massive character. It was necessary to excavate close to the foundations on both sides to a depth of 17 feet 6 inches—every precaution was used to insure safety: the workmen were employed day and night. In fourteen days and nights of unremitting labor these constructions were safely passed; the south-west gateway appeared to have been built on made ground, and was considerably out of perpendicular when the works commenced. A slight settlement in the northern abutment was observable during the progress of the work, but it has now stood one year without further injury.

58. In June 1860, the immense quantity of water which had to be contended with, rendered it almost impossible to proceed, and the works to Dhurrumtollah Main Sewer were suspended till the end of the rainy season, when they were resumed. The entire length from Circular Road to end of Old Post Office Street was completed at the end of March of the present year.

The total length of the Dhurrumtollah Sewer constructed is 8,110.

59. It now remains only to connect it with the Canal, a distance of 300 feet, which will be completed by the end of

the present year, when this Sewer, with its branches, may be brought into practical operation.

60. For connecting this Sewer with its branches the requisite junctions have also been carried out, as follows:—

Junctions—Size of Sewers.	Side of Main Sewer.	Opposite to
No. 9* ...	South ...	Premises No. 72.
No. 9 ...	North ...	Dingabhanga Lane, between premises 48 and 49.
No. 9 ...	South ...	Between premises 80 and 81.
No. 9 ...	North ...	East side of Union Chapel.
9-inch ...	North ...	St. James' Lane, between premises 41 and 42.
9-inch ...	South ...	Mott's Lane, between premises 85 and 86.
9-inch ...	North ...	Gungaram Paulit's Lane.
No. 9 ...	North ...	East side of Wellington Square.
No. 3 ...	South ...	Wellesley Street.
No. 3 ...	North ...	Wellington Street.
No. 7 ...	South ...	Jaun Bazar 4th Lane.
No. 9 ...	North ...	Hospital Lane.
9-inch ...	South ...	Nilmony Holdar's Lane.
No. 7 ...	North ...	Chandney Choke Street.
No. 4 ...	North ...	Cossitollah.
No. 4 ...	South ...	Chowringhee Road
9-inch ...	North ...	Dacre's Lane.
No. 6 ...	North ...	Government Place, East.
9-inch, 4 Junctions...	North ...	Government House compound.
No. 6 ...	North ...	Government Place, West.

* The internal dimension of the Sewers for the Drainage of Calcutta are as follows:—
(All the Sewers are egg-shaped.)

No of Sewer.	Height of Sewer.	Width of Sewer.
1	9·4½	7·3
2	8·1½	6·3
3	6·6	4·4
4	6·0	4·0
5	5·6	3·8
6	5·0	3·4
7	4·6	3·0
8	4·0	2·8
9	3·6	2·4
10	3·0	2·0

Side Entrances.

No. 1	...	North Side	... Near East Gate of Union Chapel compound.
No. 2	...	South	... East Corner of Wellesley Street.
No. 3	...	North	... East Corner of Jaun Bazar 4th Lane.
No. 4	...	North	... East Corner of Chowringhee Road.
No. 5	...	North	... East Corner of Old Court House Street.
No. 6	...	South	... West Corner of Government Place, West.

Thirty-seven man-holes.

One hundred and fifty 4-inch junctions, for surface drainage.

61. The junctions of the larger Sewers, Nos. 3, 4, 6 and 7, in the above list, are all effected with a curve of 40 feet radius, to which the direction of the Main Sewer is a tangent. The work at these places is of a very heavy and expensive character, necessitating an excavation of 20 feet in width: from the peculiar taper form given to the arch, it is a somewhat difficult piece of brick-work to execute, but the whole of them have stood perfectly well—the traffic of the street has now been running over them many months.

62. In all cases where the junctions have been constructed, a portion of the side Sewer has also been constructed for 30 to 40 feet in length, according to circumstances.

The *side entrances* extend from the side of the Sewer, close to the premises on the side of the street.

Their use is to permit access to the Sewer for examination and repairs, without the necessity for breaking up the roadway.

63. The *man-holes* are built *over* the Sewer, and extend to within 2 feet of the surface of the road; they are 200 feet apart along the whole course of the Sewer, the internal dimensions 2 feet square; at the top they are covered with stone, which can easily be removed, without destroying the brick-work. These man-holes are intended to facilitate the cleansing of the Sewer, and are now most useful, as the mud, brick, rubbish, &c., collected during the building of the Sewer, are being removed. When it becomes necessary

to connect house drains, &c., the workmen and materials will be able to get within a convenient distance of the required spot, never exceeding 100 feet.

64. The 150 *four-inch junctions* alluded to are for the purpose of admitting the surface drainage water from the streets, and will hereafter be connected with the gully pits to be built at the margin of the Foot-paths.

65. The cubic content of brick-work in the Durrumtollah Sewer is 50 feet per foot in length.

By calculation the sectional area of the excavation is 250 feet.

The surplus soil is 100 cubic feet per foot forward.

The quantity of brick-work executed		405,500	feet.
The excavation		2,027,500	,,
Surplus soil		811,000	,,
The number of bricks may be stated at	5,000,000		
Extra for packing sides of excavation and paving the roadway	1,000,000		
		6,000,000	

To these numbers a considerable addition must be made for the extra work to the junctions alluded to in the above list.

66. The total cost of labor for the whole has been Rupees 1,39,203-15-5, including cartage of materials, but exclusive of the removal of surplus soil, or about Rupees 16 per foot forward. This is considerably in excess of the amount I had estimated, but, considering the difficulties experienced, it is not greater than might be expected.

67. The nature of the ground rendered it imperative to close pile by far the greater portion of the excavations; the ramming down of the piles by an engine, and after extraction of them by the aid of levers, is a matter of great labor, where it has to be done continuously.

In such cases, also, great care has to be observed in the filling up of the holes left by these piles.

It will be easily seen that, when the piles are drawn, a continuous vacant space is left on both sides of the Sewer, which is loaded with a weight of earth equal to 4 tons per foot in length, and tends to flatten the Sewer at the crown, and spread the width at the sides.

68. Every care is requisite in building the side walls of the Sewer to see that all vacant spaces are built in solid; and this has for the most part been done with broken bricks and hard rubbish. However carefully this may have been done, the pile holes above alluded to present a certain source of mischief, which is wholly unavoidable.

These should always be filled immediately with mud poured in from the top, and washed in with water; this very effectually fills the hole with a semi-fluid substance, which, when dry, is as solid as the surrounding soil.

It has always been an object to do this as soon as possible, by drawing alternate piles after the brick-work is finished, but time and a considerable length of open excavations are required, and these it is almost impossible to obtain.

69. The very nature of the work, carried on as it has been in the middle of a thoroughfare, along which carriages are continually passing and re-passing, the complaints of obstruction and inconvenience which urge on the completion of the work, frequently induce the Engineer to do that which his better judgment would forbid.

I am, however, glad to say, that the danger from these causes, by constant care, has been obviated, and no serious injury has resulted; in one place only was it necessary to replace any portion so injured.

70. The levels of the Sewers, on the accuracy of which the after-working of the Sewer and its self-cleansing action

mainly depend, has been a matter of considerable anxiety and care. For some time I had to attend and give the levels for every successive 12 feet length myself, involving frequent delays.

71. I have now arranged a system, by which the Assistants can very accurately put in the levels for the works themselves, requiring only occasional checking to see that the marks, sights, &c., which they use, are properly and correctly fixed, and remain unmoved.

This is done by fixing two wooden Ts in the road at the correct inclination of the Sewer, one above the other at a short distance from each end of the work; a third larger and moveable T is also used, the length of which is calculated to be equal to the height of the Ts above the level of the invert of the Sewer.

The Assistants can with great accuracy sight in the levels between any two such Ts when properly fixed; in one case only has it been necessary to make any alteration; in this case it was found that a wrong T had been used, and 20 feet of the Sewer was laid too high.

72. It became necessary to cut out the bottom of the Sewer and lay it lower. I had the great satisfaction of finding that in this case, though laid in soft bad ground, the cement of the Sewer was firm as a rock, and the soft ground underneath it appeared to have parted with its moisture and become quite firm and hard.

73. I have thus at some length noticed the difficulties attending the first heavy portion of the Drainage Works. They will, I believe, be found to attend more or less the whole of the Drainage operations.

74. Complaints have been made of injury to buildings. In several cases it was necessary to carry the excavations in dangerous proximity to large upper-roomed houses; but in

no one case has complaint been received of injury to *these;* they have come from premises originally in a dilapidated condition. I believe, in no instance are the Drainage Works justly chargeable with the settlements, if such have occurred.

OLD COURT HOUSE STREET SEWER.

75. The Old Court House Street Sewer was commenced in July of last year, and it comprises—

650 feet of	No. 6 Sewer,	which is	3′	4″	wide inside and	5′	0″	high.
860 „	No. 7 „	„	3′	0″	„ „	4′	6″	„
90 „	No. 8 „	„	2′	8″	„ „	4′	0″	„

The depths of excavation at the ends are 14 and 9 feet respectively.

The total length is 2,400 feet.

The cubic contents of the brick-work		35,347 feet.
Ditto of excavation ...		180,000 „
The number of bricks used	453,500	
Add for paving, roadway, packing, &c.	90,709	
		544,209 bricks
The surplus soil amounted to		65,600 c. ft.

The cost of the labor has been Rupees 11,286-6, or Rupees 4-10 per lineal foot, including cartage.

76. Here also large quantities of water had to be contended with; some portions of the ground proved to be very treacherous, when the excavations were deep, as near Government House compound, while at the northern end little difficulty was met with.

77. The following junctions, &c., have been constructed for connecting the collateral Drainage with this Sewer:—

Description.	*Side.*	*Opposite to*
9 inch,	East,	Banstollah Gully.
No. 8,	„	Waterloo Street.

Description.	*Side.*	*Opposite to*
No. 8,	West,	Govt. Place, North.
No. 8,	East,	Raneemoody Gully.
9 inch,	West,	Larkin's Lane.
No. 8,	East,	Mangoe Lane.
No. 9,	West,	Tank Square, South.

Side Entrances.

One at north-east corner of Government House compound.

One at south-east corner of Tank Square compound.

Twelve man-holes.

Sixty 4-inch junctions for surface drains.

78. The large old Sewer which crosses the street at the south corner of Tank Square was left standing; and the lengths of new Sewer will require to be connected when the new system is brought into operation.

79. The surplus soil was, for the most part, taken to construct the Foot-paths, which have since been completed on both sides of the street.

CHOWRNGHEE ROAD SEWER.

80. The portion of this Sewer, which falls towards Dhurrumtollah, is 4,742 feet in length.

The depth of the excavation at the ends are 15 and 8 feet respectively.

It comprises—

720	feet	of	No. 4	Sewer	6′	0″	high	and	4′	0″	wide inside.
1,345	„		No. 5	„	5′	6″	„		3′	8″	„ „
1,660	„		No. 6	„	5′	0″	„		3′	4″	„ „
1,017	„		No. 7	„	4′	6″	„		3′	0″	„ „

The total length completed is 4,250 feet, there remaining to be completed 492 feet before the approaching rainy season.

The cubic contents of the brick-work amount to		98,417	feet.
The excavation to		398,328	,,
Bricks consumed in work	1,180,000		
Add for paving and packing sides, &c.	290,000		
		———	1,470,000 bricks.
Surplus soil (by computation)		160,000	c. ft.

The cost for labor has amounted to Rupees, 21,410-7-10 or at the rate of about Rupees 5 per foot run, including cartage of materials.

81. The following junctions for side Sewers have been constructed:—

Size of Sewers.	*Side.*	*Opposite to*
No. 9,	East,	Jaun Bazar Street.
9 inch,	,,	Maxton's Lane.
,,	,,	Homayoon Place.
No. 9,	,,	Lindsay Street.
No. 9,	,,	Sudder Street.
No. 9,	,,	Kyd Street.
No. 9,	,,	Park Street.

Side Entrances.

East, at north corner of Lindsay Street.

East, at north corner of Kyd Street.

Twenty-four man-holes.

Seventy 4-inch junctions for surface drains.

82. A considerable length of this Sewer has also been laid in bad ground; 8 to 10 feet below the surface the soft stratum alluded to in the Dhurrumtollah work was reached.

It is so soft that a man standing still for a short time would sink and be unable to extricate himself; this has several times happened.

83. Though for the most part executed during the driest period of the year, pumping day and night has been necessary, in consequence of the large quantity of water which

accumulates. I believe that the beneficial effects of this Sewer will be seen immediately it is brought into operation, by the increased dryness of the houses in the Chowringhee Road; and there is satisfaction in the reflection, that where the difficulties of construction are the greatest, there the deep sub-soil drainage which the Sewer will effect is the most needed.

84. It has been necessary, in consequence of the softness of the ground and its loose character, to strengthen the work considerably by adding additional rings of brick-work, and building in all vacant spaces at the sides; this, and the covering of the surfaces of the excavation, when refilled, with broken and inferior bricks, has added considerably to the quantity of bricks and other materials consumed.

85. The only other work which it is necessary to notice is the Out-let Sewer into the Canal.

The assent of Government to the use of the site of the cess-pool, for the purpose of erecting a temporary Pumping Station, was received on the 26th November 1859.

86. It was necessary to obtain possession of the piece of land on the east side of the Circular Road, in order to connect the Dhurrumtollah Sewer with the cess-pool.

The Commissioners accordingly applied to Government to take the land as for a public purpose under the conditions of Act VI. of 1857.

The land was handed over to the Commissioners for this purpose on the 22nd of February 1860; it contains an area of 1 beegah 7 cottahs and 2 chittacks, the cost of which was Rupees 9,286.

87. The work was not immediately commenced, as it was considered desirable to make all possible progress with the Dhurrumtollah Main Sewer, for which all the available materials and labor were required.

It was also an object to secure the economy which would result from converting the large quantity of surplus soil available into bricks during the present season, and burning them upon the land adjacent to the Canal, which had been cleared for the purpose of the Mutlah Railway.

88. Permission was given by the Commissioner of Police to mould bricks upon the maidan, and the Railway authorities granted the use of the land above alluded to.

Arrangements were accordingly made to commence making bricks immediately the weather permitted, at the close of the rainy season.

Application was also made to the Magistrate of the 24-Pergunnahs to allow the bricks to be burned on the land alluded to, but here a difficulty was experienced; it was not till the 28th December 1860 that permission was obtained to burn one kiln, as an experiment.

In consequence of this difficulty no contract could be entered into, either for making the bricks, or supplying the fuel; and it was not till the 11th of January 1861 that permission to burn bricks was actually obtained, and arrangements for fuel, &c., could be made. The result of this was to deprive us of the benefit of two months, the best of the brick-making season; it delayed the work in the Canal a corresponding period, and the completion of the works before the rains could not be accomplished, as was intended. Notwithstanding the delay, thirty lakhs of bricks have been made, and are now either burning or burned.

89. This work has disposed of three lakhs of cubic feet of the surplus soil, derived from the excavations which have been made for the Sewers already constructed.

The total quantity of this surplus soil, which has been dealt with during the progress of the works, may be estimated at $6\frac{1}{2}$ lakhs of cubic feet, and has in itself presented

a formidable difficulty; as its immediate removal from the thoroughfare has been a matter of urgent necessity, often most difficult to accomplish by the only available means—ticca carts.

The cost of this kind of labor for this purpose has amounted to Rupees 12,938.

90. The works to the Out-let Sewer are now well advanced; 300 feet in length will be completed ready for arching by the middle of June, and the temporary Pumping Station will be up to ground level, and may be completed during the rainy season.

A length of 300 feet of the large Sewer will then remain to be executed when the rains have ceased, which will occupy a period of three months.

The whole of the new Sewer executed can then be brought into operation at any time; and the success of the new Drainage Works may be tested as far as the present water-supply will permit.

91. The completion of the Out-let Sewer is also of considerable importance to the further extension of the new Drainage Works to the smaller Sewers connected with the mains already laid, a list of which is given above.

By the use of the temporary Pumping Station, the works already constructed will be kept free from the sub-soil drainage water, and till this is accomplished, the laying of the tubular or pottery drains must be deferred, in order to prevent their being choked—a contingency which might occur if they have no outlet.

92. The Commissioners have procured from England a considerable quantity of tubular stone-ware drain pipes.

It appeared to me probable that about this time (May 1861) the three new Sewers would be completed, and the temporary Outlet and Pumping Station established; accordingly, on the 9th February 1860, I recommended to the Commissioners

to obtain a supply of the above material from England; and an order was given for the following assortment:—

5,000	feet	12″	
10,000	,,	9″	
20,000	,,	6″	
20,000	,,	4″	
500	,,	4″	junction blocks.
500	,,	6″	ditto
100	,,	9″	ditto
10	,,	12″	ditto

93. The two larger of these sizes will suffice for small streets, the two smaller for street surface drains and for houses and compounds, all of which may be so used as soon as an outlet is obtained for the Sewers with which they are to be connected.

94. The timber for excavations has also been a heavy expense, the nature of the ground has rendered it absolutely necessary. A large quantity of this is still available for further operations.

The lime has chiefly been purchased from Messrs. Mair and Co., and Messrs. Kaas, Perrot and Co.: both these supplies have proved to be very satisfactory.

95. The implements have been chiefly purchased in Calcutta; all the wood-work has been done in the Ballia-ghatta Shops.

Kodalies, picks, &c., have been obtained from England by indent.

96. I have only to add that I have used every endeavor to economise the work, both in superintendence, and in the cost of the labor and material.

The former has been obtained on the spot, from men never before on works of this character. I have found it necessary to have one, and occasionally two, persons at every place

where the works have been in progress; the average number employed has been 20, which includes those at the ghâts, work-shops, &c.

97. The total amount of wages of assistants in Calcutta, including the salary of the Engineer for three years and ten months, amounted to Rupees 97,603-13-8, and at Kotrung, Rupees 17,930-11. This is more than the estimate I had formed, but experience has taught me that it is more expensive still to omit this item of expenditure.

I have the honor to be,

GENTLEMEN,

Your obedient servant,

W. CLARK.

MEASUREMENT OF BRICK MASONRY BUILDINGS AT KOTRUNG STEAM WOKS.

Engineer's bungalow	19,881	cubic feet.
Superintendent's ditto	18,034	„
Assistant's house	6,995	„
Durwan's ditto	412	„
6 brick-sheds, &c.	29,143	„
2 machine sheds	12,243	„
Engine house	8,599	„
Boiler house...	5,917	„
New Blacksmith's shop (not finished)	4,300	„
Foundry ditto	5,118	„
Soorky mill shed	1,266	„
Work-shop	6,374	„
Wood godown	1,625	„
Carried Over ...	118,907	cubic feet.

Brought Over ...	118,907	cubic feet.
Moody's shop, with arched roof ...	4,663	„
Writer's office	665	„
Chimney	6,178	„
8 pits for table moulding bricks ...	3,228	„
Wall in front of Engineer's bungalow	2,591	„
5 small bridges	652	„
Gate	440	„
Drains	1,200	„
Drying floor for bricks	3,334	„
Total ...	142,858	cubic feet.

MEASUREMENT OF KUTCHA-PUCCA BUILDINGS AT KOTRUNG.

Sircar's house	1,697	cubic feet.
Coolies' huts, No. 1 range	2,396	„
Coolies' ditto, range Nos. 2 to 6 ...	23,436	„
1 circular kiln	5,509	„
1 square ditto	6,028	„
1 lime ditto	1,575	„
Total ...	40,641	cubic feet.

APPENDIX B.

Dr. **CASH ACCOUNT of Receipts and Disbursements of the new Drainage Fund for the Year 1858.** Cr.

Receipts.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
To Balance of Cash in the Bank of Bengal on the 31st December 1857	.....			.....			39,188	13	8
„ Government 5 per cent. Promissory Notes of 1856-57, dated 28th February 1857, viz :—									
„ 5 Pieces, 10,000 at 11 per cent. discount cost 8,900 charged 9,027 8 4									
„ Interest at 4 per cent. on 4,000 Rs. from 31st December 1856 to 12th October 1857, Rs. 125-12-4 at 11 pes cent. discount 113 2 11									
„ Ditto ditto on Rs. 2,000 from 1st August 1856 to 12th October 1857, Rs. 120 at 20 Rs. per cent. discount 96 0 0									
	208	2	11						
„ 11 Pieces, 22,000 at 14 per cent. discount, cost 18,920 0 0									
„ Interest on ditto at 5 per cent. from 12th August to 23rd September, 1857, Rs. 123-3-6, at 14 per cent. discount	105	2	0						
	19,025	2	0						
Rupees	28,260	13	3						
To Interest on the above 2 Pieces of 5 per cent. Notes transferred from 28th February to 9th June 1858, 3 months 10 days	.....			55	8	10			
Less discount at 10 per cent.	.....			5	8	10			
							50	0	0
„ Amount refunded by Mr. Agabeg, being interest overpaid on purchase of Government Promissory Notes	.....			.....			49	13	6
„ Amount set apart by the Municipal Commissioners from the Collections of House Rate under Section XXV. of Act XXVII. of 1856, Rs. 62,470-5-4 to make up Rupees 150,000 for the 1st year, and Rupees 85,600 on account of 2nd year aggregating ...	.....			.....			1,48,070	5	4
„ Rent and Grazing Cattle, Fees, &c. realized from Kotrung Char Land	.....			.....			120	11	0
„ Interest on 22,000 Rupees from 31st August 1857 to 27th February 1858 @ 5 ₹ cent ...	550	0	0						
„ Ditto on 28,000 Rupees from 28th February to 31st August 1858 @ 5 ₹ cent ...	700	0	0						
				1,250	0	0			
„ Less Bank of Bengal's Commission @ 4 ₹ cent.	.....			3	2	0			
							1,246	14	0
„ Coolies and Durwans' fine...	.....			.....			10	1	9
Company's Rupees ...	.....			.....			1,92,336	11	3

Disbursements.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
By Engineer's Salary	19,500	0	0						
„ Office Establishment	838	7	3						
„ Establishment for preparation of Materials	3,796	11	3						
„ Levelling Account	766	0	3						
„ Calcutta Executive Establishment	1,024	0	0						
„ Purchase of Roman Cement	856	12	0						
„ Calcutta Cattle and Carts	331	12	9						
„ Calcutta Machinery Account	34	14	6						
„ Chowringhee Footpath surface Drain Account (Channel Stone)	585	0	0						
„ Surface Drain Account (Cast Iron Gratings, &c.,)	2,144	6	8						
„ Working Implements	1,674	12	0						
„ Ballieghatta Depôt Building	1,711	1	6						
„ Timber purchase Account (Saul and Teak Timbers and Pine Boards, &c.,)	3,473	15	9						
„ Purchase of Boat Account	1,280	1	9						
„ Kotrung Land Account, viz., Purchase of Char Land including Compensation	50,474	6	2						
Less Amount refunded by Mr. Heysham overdrawn	379	7	4						
	50,194	14	10						
Add sundry Charges for Earthwork, &c., ...	2,148	2	3						
	52,343	1	1						
„ Kotrung Office Furniture Account	119	12	0						
„ Ditto Building Account	4,243	6	0						
„ Ditto Machinery Account	39,137	6	1						
„ Ditto Coal Account	2,301	4	6						
„ Ditto Working Implements	2,474	12	6						
„ Ditto Lime Account	1,067	13	9						
„ Ditto Sundry Account	198	12	11						
„ Ditto Brick Manufactory Account	760	11	4						
„ Ditto Road Account	1,301	9	3						
„ Ditto Bungalow Account	1,196	2	6						
„ Ditto Cattle and Carts	340	3	9						
„ Ditto Brick Account 12,951 11 0									
Deduct, Advances of 1857 accounted for in 1858... ... ... 209 0 0									
	12,742	11	0						
							1,56,226	0	4
Contingent Expences.									
„ Charges General, viz., Amount remitted to Mr. Rendal for his Report on the Plan of Calcutta New Drainage 1,484-8-6, Sundry other charges 479-1-9	1,963	10	3						
„ Water-carriage of Materials (Boat-hire &c., for carrying Bricks, &c., from Kotrung ...	759	9	3						
„ Brokerage on purchase of Government Promissory Notes	33	12	0						
„ Advertisement Charges	41	0	0						
„ Printing Charges	232	4	0						
„ Stationery Account	194	11	3						
„ Ballieghatta Depôt Account (Coolies for stacking Bricks, &c.,)	79	12	3						
„ Kotrung Charges General (Sundry petty charges)	279	3	0						
„ Kotrung Stationery Account	5	3	0						
							3,588	14	6
Advances.									
„ Advances to Brick Contractors for making bricks	2,973	4	0						
„ Baboo Ramdhun Ghose : balance of advance for petty cash payments ...	1,549	13	7						
„ F. N. DeGarmer : Advance on account of sundry expenses at Kotrung ...	500	0	0						
„ W. Williams ditto ditto at Calcutta	100	0	0						
							5,123	1	7
Balance.									
„ Cash in the Bank of Bengal on the 31st December 1858 on Drainage Account	26,700	6	10						
„ Ditto ditto ditto on Interest ditto	698	4	0						
							27,398	10	10
„ Government Promissory Notes in the Bank of Bengal on 31st December 1858 :—									
„ 4 Promissory Notes of new 5 per cent. Loan of 1856-57, dated 28th February 1857, viz.—									
„ 3 „ for 2,000 each 6,060 @ 11 per cent dis. 5,340 charged ... 5,407 8 4	208	2	11				5,675	11	3
„ 11 „ „ 1,000 each 22,000 @ 14 ditto 18,920 ... 18,920 0 0							18,920	0	0
28,000				24,260					
Company's Rupees ...	208	2	11				24,595	11	3
	.....			.....			1,92,336	11	3

Examined.

R. LLOYD, } *Auditors.*
RICHD. BLECHYNDEN, }

CALCUTTA
20th March 1859.

TARRENEY CHURN NEWGY.
Deputy Accountant.

APPENDIX C.

Dr. *CASH ACCOUNT of Receipts and Disbursements of the New Drainage Fund for the Year 1859.* *Cr.*

Receipts.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
To Balance of Cash in the Bank of Bengal, on the 31st December 1858	.....	..	..	26,700	6	10			
" " " on Interest Account	.....	..	..	698	4	0			
" Amount set apart by the Municipal Commissioners from the Collections of House Rate under Section 23 of Act XXVIII. of 1856	.....	..	..	159,500	0	0	27,398	10	10
" Interest on 5 per cent. Government Promissory Notes, aggregating Co.'s Rs. 28,000, from 31st August 1858 to 31st August 1859 @ 5 per cent.	1,400	0	0						
" Less Bank of Bengal's Commission @ 4 annas per cent.	3	8	0	1,396	8	0			
" Proceeds of Sale of Roman Cement	250	0	0						
" " of Lime	65	0	0						
" " of Sourkey	30	0	0						
" " of a Boat	350	0	0						
" " of Bricks	90	6	4						
" " of Old Stores of Barque *Benares*	4,469	14	9						
" Rent realized from Kotrung Chur Land	.....	..	..	5,255	5	1			
" Amount refunded by Mr. Williams, being balance of his Account	100	0	0	195	0	0			
" " " by Sinaikh Musuhuddee and Montaux, Brick Contractors, ditto	402	0	0						
" Amount transferred from F. N. D'Garnier's Account to Mr. James Leeming's Account	500	0	0						
" Loan from General Fund	.....	..	..	1,002	0	0			
				6,000	0	0			
Contingent Receipt.									
" Amount of Fine	.....	..	..	28	3	6			
Government 5 per cent. Promissory Notes							173,377	7	7
" 14 Promissory Notes, dated 28th February 1857, aggregating Rs. 28,000, cost	.....	..	..	24,595	11	3			
Company's Rupees	.....	..	..	.....	..	..	200,775	14	5

Disbursements.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
By Office Furniture Account	216	4	0						
" Working Implements Account	10,760	11	11						
" Calcutta Cattle and Carts Account	1,891	15	0						
" Calcutta Machinery Account	358	5	1						
" Chowringhee Footpath Surface Drain Account	5,023	1	4						
" Surface Drainage Account	508	1	3						
" Balleghatta Depôt Buildings	3,581	6	3						
" Kotrung Land Account	1,427	5	0						
" " Building Account	5,184	10	11						
" " Machinery Account	12,238	2	5						
" " Working Implements Account	3,427	7	6						
" " Coal Account	24,697	0	4						
" " Lime Account	1,378	14	2						
" " Sourkey Account	695	3	1						
" " Brick Manufactory Account	2,819	8	3						
" " Road Account	2,606	12	0						
" " Bungalow Account	2,228	10	2						
" " Office Furniture Account	10	0	0						
" " Cattle and Carts Account	7	13	3						
" Timber Purchase Account	9,513	7	3						
" Purchase of Boat Account	513	13	6						
" Brick Account	4,962	0	3						
" Stone Ware Account	4,389	15	9						
" Dharmtollah Main Sewer Account	14,578	4	8						
" Barque *Benares* Account	29,318	12	3						
" Calcutta Iron Account	118	11	0						
" Kotrung Iron Account	724	14	3						
" Calcutta Coal Account	299	8	6						
" " Lime Account	766	12	6						
" " Sourkey Account	116	4	0						
							141,363	12	6
" Engineer's Salary	16,500	0	0						
" Office Establishment	842	13	9						
" Establishment for preparation of Materials	5,075	4	2						
" Calcutta Executive Establishment	5,056	10	6						
" Levelling Account	112	0	0						
							27,586	12	5
Contingent Expenses.									
" Charges General	715	8	9						
" Balleghatta Depôt Account	1,355	15	9						
" Water Carriage of Materials	4,655	14	6						
" Kotrung Charges General	244	2	9						
" Stationery Account	149	9	6						
" Advertisement Charges	93	5	6						
" Printing Charges	486	9	6						
" Kotrung Stationery Account	1	4	0						
" Mullick's Ghaut Depôt Account	217	7	9						
							7,919	14	0
Advances.									
" Advances to Brick Contractors for making Bricks	4,408	12	0						
" Baboo Ramdhone Ghose: balance of advance for petty cash payments,	7,045	9	9						
" J. J. Blend: advance on account of sundry Expenses at Calcutta	200	0	0						
" Owen Green: balance of account for Ditto	100	0	6						
" James Leeming: amount transferred from D'Garnier's Account for sundry Expences at Kotrung	500	0	0						
							12,254	5	9
Balance.									
" Cash in the Bank of Bengal, on the 31st December 1859 on Drainage Account	.....	..	..	.....	..	..	11,650	14	9
Government Promissory Notes in the Bank of Bengal, on 31st December 1859.									
" 14 Promissory Notes of new 5 per cent. Loan of 1856-57, dated 28th February 1857, aggregating Rs. 28,000 cost.	.....	..	..	24,595	11	3			
							189,124	12	8
Company's Rupees	.....	..	..	.....	..	..	200,775	14	5

Examined.

R. LLOYD,
RICHD. BLECHYNDEN, } *Auditors.*

CALCUTTA,
22nd March 1860.

TARRENEY CHURN NEWGY,
Deputy Accountant.

APPENDIX D.

RECEIPTS and DISBURSEMENTS of the Drainage Fund for the Year 1860.

RECEIPTS.

	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
To Balance of Cash in the Bank of Bengal, on the 31st December 1859							11,650	14	9
GOVERNMENT PROMISSORY NOTES.									
„ Proceeds of sale of 14 pieces of 5 per Cent. Notes of 1856-57 for Rupees 2,000 each, aggregating	28,000	0	0						
Less discount on Rs. 22,000 at 5 Rs. 4 As. per cent.	1,155	0	0						
Ditto ditto on „ 6,000 at 5 „ 8 „ ditto	350	0	0						
Ditto Banks Commission on Rs. 28,000 at 4 As.	70	0	0						
	1,555	0	0	26,445	0	0			
INTEREST ACCOUNT.									
„ Interest on Government Promissory Notes for Rupees 28,000, from September 1st, 1859 to 28th February 1860, at 5 Rs. per cent	700	0	0						
Less Banks Commission at Rs. 0 4 As. per cent	1	12	0						
	698	4	0						
„ Broken Interest on ditto for five days	19	7	1						
Less discount	1	0	6						
	18	6	7						
„ Interest allowed by Agra Bank on Current Account during the year 1860	53	2	5						
				769	13	0			
„ Loan from Agra Bank, Calcutta Branch	1,26,000	0	0						
Less Amount not drawn until 2nd January 1861	825	0	5						
	1,25,174	15	7						
„ Amount transferred from Agra Bank old Loan Account to Mortgage Loan Account and subsequently receipt of 2 Instalments of the Bond	* 1,62,000	0	0	2,87,174	15	7			
„ Proportion set apart by the Municipal Commissioners from the House Rate Collections during the year 1860				2,11,000	0	0			
„ Proceeds of sale of 80 Maunds of Copper of Barque *Benares*				3,199	0	0			
„ Rent of Kotrung Ghat Land	176	13	3						
„ Ditto of Cox's House at Harrytollah	40	0	0						
				216	13	3			
SURPLUSS.									
„ Amount Advanced from General Fund	18,407	0	5						
„ Ditto ditto from Lighting Rate Fund	5,402	3	1						
„ Difference of proceeds of a set of Bills on Agra Bank, London... ...	315	6	7						
				24,124	10	1			
„ Income Tax deducted from Salaries of the Establishments not yet remitted...	549	0	5						
„ Less excess refunded	1	4	3						
				547	12	2			
ADVANCES.									
„ Amount advanced to Hurroschunder Mookerjee and Joygopaul Banerjee in 1859, refunded	490	0	0						
„ Ditto ditto to Sheik Enamuddee in 1859, refunded	1	0	0						
„ Ditto ditto to Baboo Ramdhun Ghose in 1859, refunded	9,103	12	1						
				9,594	12	1			
CONTINGENT RECEIPTS.									
„ Rent for laying a mast at Mullick's Ghaut Depôt	10	0	0						
„ Amount for damage done to a lintern	6	8	0						
				16	8	0			
							5,63,089	4	2
Carried forward, Co's Rs. ...							5,74,740	2	11

DISBURSEMENTS.

	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
By Engineer's Salary	18,000	0	0						
„ Ditto House allowance, from 16th October to 30th November 1860 at 150 Rs. per mensem	227	7	0						
				18,227	7	0			
„ Office Establishment	1,283	7	3						
„ Calcutta Executive Establishment 12,291 2 4									
„ Less refunded by Mr. Myer 50 0 0									
	12,241	2	4						
„ Establishment for preparation of Materials	6,956	15	0						
				20,481	8	7			
							38,708	15	7
„ Dharrumtollah Main Sewer	1,13,329	10	6						
„ Old Court House Street Branch Sewer	10,250	2	9						
„ Chowringhee Road Branch Sewer	6,594	5	0						
				1,30,174	2	3			
„ Chowringhee Road Footpath Surface Drain	41	9	6						
„ Old Court House Street Footpath Surface Drain	1,470	10	6						
				1,512	4	0			
							1,31,686	6	3
„ Calcutta Cattle and Carts	5,588	15	6						
„ Kotrung Cattle and Carts	311	14	9						
				5,900	14	3			
„ Calcutta Machinery	11,669	11	0						
„ Kotrung Machinery	11,175	3	6						
				22,844	15	6			
„ Stone Ware Pipes				17,890	9	8			
							46,636	5	5
„ Calcutta Coal	2,305	10	0						
„ Kotrung Coal	11,479	3	9						
				13,784	13	9			
„ Calcutta Lime	15,449	9	2						
„ Kotrung Lime	4,140	9	0						
				19,590	2	2			
„ Calcutta Soorkey	1,833	11	6						
„ Kotrung Soorkey	1,895	7	3						
				3,729	2	9			
							37,104	2	8
„ Calcutta Working Implements	22,896	3	11						
„ Kotrung Working Implements	4,725	13	6						
				27,622	1	5			
„ Calcutta Timber purchase	16,825	11	0						
„ Kotrung Timber purchase	2,812	3	9						
				19,637	14	9			
							47,260	0	2
„ Brick Account	3,677	1	0						
„ Calcutta Brick Manufactory	238	7	6						
„ Kotrung Brick Manufactory	3,053	15	3						
				6,969	8	6			
							6,969	8	6
„ Removing Surplus Soil							9,820	0	9
PURCHASE OF PAULT'S LAND.									
„ Cost of Land 8,676 0 0									
„ Compensation to Ryots 160 0 0									
„ Arbitrator's fee... ... ... 450 0 0									
	9,286	0	0						
							9,286	0	0
„ Bellieghatta Depôt Building	353	12	9						
„ Mullick's Ghaut Depôt Building	168	8	6						
„ Kotrung Building...	6,720	13	6						
				7,243	2	9			
„ Kotrung Road	710	12	0						
„ Kotrung Bungalow	678	5	9						
„ Kotrung Bungalow Furniture	375	0	0						
„ Boat Repairing Charges	433	8	0						
„ Charges for breaking the Barque *Benares*	795	11	0						
„ Bellieghatta Depôt	2,385	1	5						
„ Mullick's Ghaut Depôt	4,686	7	0						
„ Bellieghatta Canal	35	0	6						
„ Kotrung Office Furniture	4	0	0						
„ Calcutta Office Furniture	102	8	6						
				10,201	6	2			
„ Mr. Blond's Office Rent				198	15	0			
„ Lighting, Watching and Fencing				2,835	0	6			
„ Stationery				137	5	6			
„ Water Carriage of Materials				10,611	3	9			
„ Kotrung Land				10,307	15	4			
„ Advertisement Charges				208	12	9			
				41,763	13	9	3,27,471	7	4
Carried forward, Co's Rs. ...									

RECEIPTS and DISBURSEMENTS of the Drainage Funds for the year 1860.—(Concluded.)

RECEIPTS.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
Brought forward, Co.'s Rs. ...	... ...	...	...	... ...	...	...	5,74,740	2	11
Company's Rupees ...	... ...	...	...	... ...	...	...	5,74,740	2	11

DISBURSEMENTS.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
Brought forward, Co.'s Rs.	... ...	...	...	41,712	13	9	3,27,471	7	4
By Printing Charges	... ...	...	...	733	14	4			
„ Interest paid to the Agra Bank on Loan Account	... ...	...	...	2,383	0	0			
„ Law Charges	... ...	...	...	862	4	6			
CONTINGENT CHARGES.									
„ Engineer's Conveyance to Kotrung	260 0 0								
„ Commissioner's Conveyance, &c.	37 0 0								
„ Dr. Ivan's Medical Attendance to Workmen	550 0 0								
„ J. Mackintosh for Surveying and Reporting Sundry Premises	192 0 0								
„ Mr. Watt's Gratuity granted by the Commissioners	50 0 0								
„ W. B. R. Harvey's award for purchasing Machinery	500 0 0								
„ Compensation for loss of a horse belonging to Hazee Mahomed	1,200 0 0								
„ Ditto for ditto of Mr. Cox's premises	272 0 0								
„ Medicines	163 11 6								
„ Chuprassies and Punkah-pullers' additional wages...	54 10 0								
„ Sundry other Charges	209 9 6								
	3,488	13	0						
„ Kotrung Charges General	327	9	3						
				3,816	8	3			
							49,359	8	10
ADVANCES.									
„ Baboo Ramdhun Ghose for Petty Cash Payments...	2,661	13	11						
„ Kotrung Suspense Account, amount advanced for Expenditure at Kotrung, from 5th August to 22nd December 1860	18,513	10	3						
„ James Leeming ditto ditto	500	0	0						
„ J. J. Blood for Calcutta Expenditure	200	0	0						
„ William Eames, Contractor for making Bricks	5,000	0	0						
„ Mohendronauth Doss, ditto for ditto	1,721	7	0						
„ Bulram Nusker, ditto for ditto	64	0	0						
„ Pun hamundo Doss, ditto for Stamp for ditto	1	0	0						
„ Ramnuram Kuru, ditto for making Bricks	1,267	4	9						
„ Hurrischunder Mookerjee and Co., Contractor for making Bricks	457	0	0						
„ Abdool Gofoor, ditto for ditto	259	8	0						
„ Mobhoosoodun Sirkar, ditto for ditto	1,370	14	0						
„ Toylukonauth Bose, ditto for ditto	413	0	0						
„ Sumbhoochunder Roy, ditto for ditto	16	0	0						
„ Bhootnauth Ghose, ditto for ditto	1,030	9	0						
„ Okeel Sirdar, ditto for ditto	168	0	0						
„ Bhyrub Kurn, ditto for ditto	91	0	0						
„ Shaik Kureembuxs, ditto for ditto	202	0	0						
„ Greeschunder Banerjee, ditto for carrying Bricks from Akra	1,000	0	0						
„ Luckinarain Coosr, ditto for making Bricks	41	0	0						
„ Brojonauth Dhur for Stamp, ditto for ditto	1	0	0						
„ Kistoprosono Roy for Stamp, ditto for ditto	1	0	0						
				34,980	3	5			
							34,980	3	5
BALANCE.									
„ Balance of Cash in the Bank of Bengal, on 31st December 1860 ...	... ...	...	...	242	6	11			
„ Ditto of Ditto in the Agra and United Service Bank, on 31st December 1860 ...	... ...	...	...	1,62,486	8	5			
							1,62,728	15	4
Company's Rupees ...	... ...	...	...	... ...	...	...	5,74,740	2	11

R. LLOYD,
RICHD. BLECHYNDEN, } *Auditors.*

TARRENEY CHURN NEWGY,
Deputy Accountant.

CALCUTTA:—SAVIELLE & CRANENBURGH, *Printers*, BENGAL PRINTING COMPANY LIMITED.